Investigation of Vertical Beam Blow-up during Centering
Run 1357 MP

J. Poole and K. Dahlerup-Petersen

Introduction

The object of this investigation was to search for the origins of the vertical blow-up of the beams observed recently on several occasions during the centering procedure. The incident has been difficult to reproduce because of its unsystematic nature. All previous tests have been futile as it has not been possible to provoke the blow-up when needed for investigations. Although the present work did not reveal the cause of the blow-up, some interesting observations were made and the effect of horizontal stabilisation tune shifts was demonstrated to be negligible.

Measurements

Ring 1 was assigned for this test but before it was available we were able to take advantage of an unwanted 35 A stack at 26 GeV in Ring 2 which had been used for tests on the feedback. This stack had already been centred but it was moved up in the aperture again by running the centring procedure in reverse. It is known that this is a non-reversible process due to hysteresis effects, but it was useful to observe the stack during the process.

The master files for centering were applied by ACCZ in reverse order and the stack moved up whilst the vertical beam transfer function (BTF) was monitored and the beam profile observed on the sodium curtain monitor. The FFT analyser was set to average over 2 sweeps so that rapid changes in the BTF could be observed, and effectively changes in the shape were observed.

During the de-centering of Ring 2 a vertical blow-up was observed (Fig. 1) and it can be seen that this blow-up was of the same order as has been observed in the Ring 1 accidents. In this case, however, the blow-up was at the bottom and it was clear that the blow-up occurred when part of the working line crossed the diagonal.

When Ring 1 was available checks were made using pulses to measure the working line distortion introduced by the horizontal stabilisation tune shifts conventionally applied during stacking. Figure 2 shows the horizontal tune distribution before and after 4 such shifts were applied.

34.5 Amps were then stacked in Ring 1 and the tests previously made using OLIV to change the QT, SF, SD, SLQ and LBQ supplies individually by the amounts required for centering were repeated. Once again it was not possible to cause any beam blow-up.

The first centering step was then applied and the vertical beam transfer function and beam profile observed. After this step the working line was measured using the FFT/BTF technique. The process was repeated for the second and third centering steps and no blow-up was observed.
The beam was then de-centred as had been done for Ring 2, repeating the observations of BTF and profile. On this occasion no blow-up was observed but the line had not crossed the diagonal, only moved close to it at the bottom. The stack was then kicked several times with the Q-kicker and a small blow-up at the bottom was observed (Figure 3).

Results and Conclusions

The beam transfer functions were observed to distort during the centering changes in a somewhat erratic way. The characteristic peak at the bottom was seen to move upwards in frequency corresponding to a maximum change in tune of ~0.02. At the same time the top edge moved down by a very much smaller amount corresponding to ~0.005. The changes were fast (21/4 sec.) and the transfer function returned to its original form afterwards.

The magnitude of these changes is greater than can be expected from any asynchronism between the Main and the other correctors. If, however, changes of the tune at the top were as large as those observed at the bottom then the line could cross the diagonal and a blow-up could result. This effect was not observed, however.

The working line measurements made between centering steps showed, as expected, the line to be unchanged by the procedure.

To summarise the results one can say that the effects of stabilisation tune shifts are negligible and the overall effect of the centering steps is not erroneous. The observation of blow-up when crossing onto the diagonal was very similar to the effects observed after accidental blow-ups. This suggests that this is a possible final step in the blow-up mechanism. If the tune was to fluctuate as much at the top of the stack as it was observed to do at the bottom, then the working line could be pushed up to the diagonal. The reasons why this could happen, however, are not known.

K. Dahlerup-Petersen  J. Poole